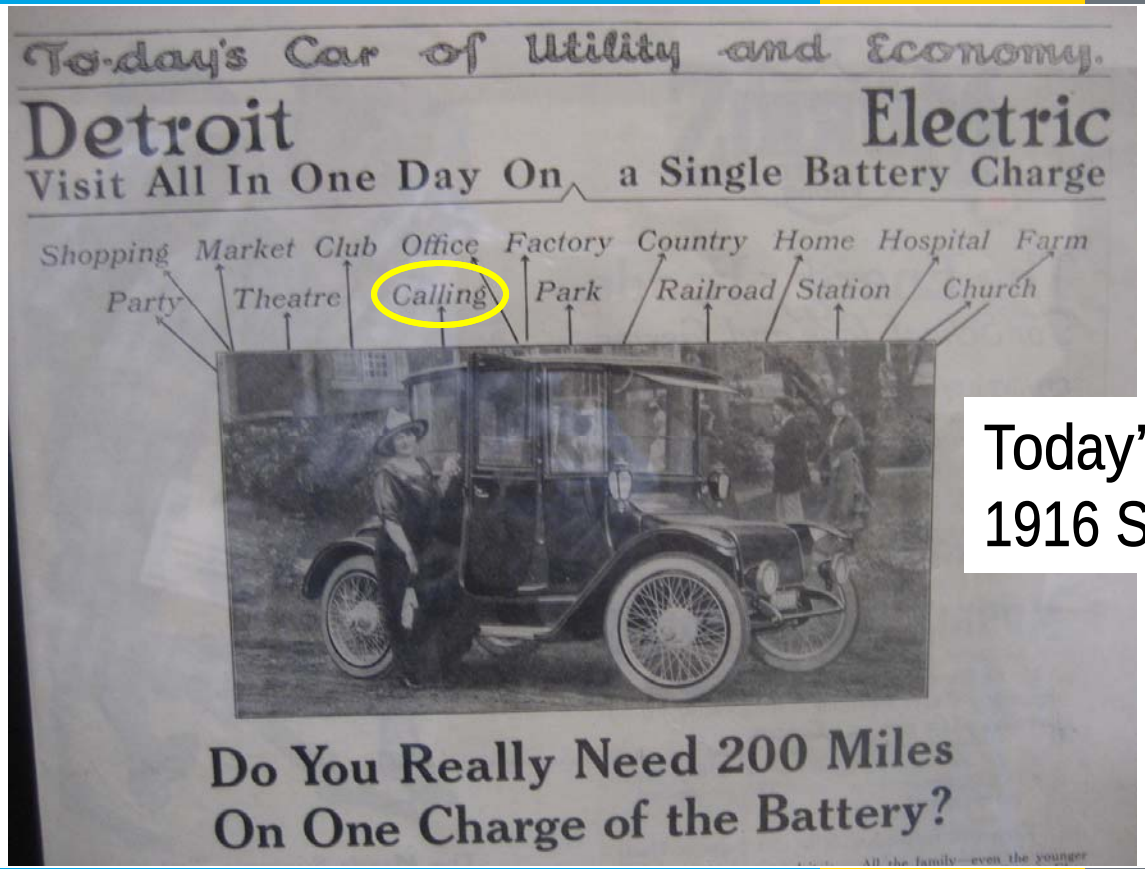
EVSE-PEV Interoperability Standards Updates; Managed Energy Networks for EVSEs in Workplace/Multi-Unit-Dwelling Installations



Today's Headline, or
1916 Saturday Evening Post?

Personal favorite listed task: *'Calling'*
...since there were no/few phones in 1916

Electric Vehicle Fall 2013 Quarterly
Discussion Webinar
September 25, 2013

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Classic Interoperability-Definitions
(only 16 letters but 8 syllables) www.merriam-webster.com/dictionary/interoperability

interoperability

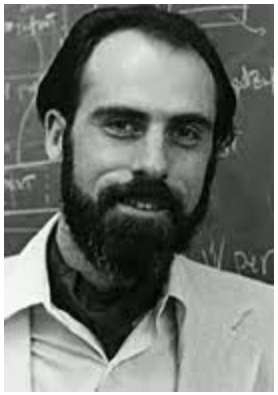
in·ter·op·er·a·bil·i·ty

\ˌin-tər-ˌä-p(ə-)rə-ˈbi-lə-tē

noun: ability of a system (as a weapons system) to work with or use the parts or equipment of another system

Interoperability Pioneers:

Luther Simjian
Father of the ATM



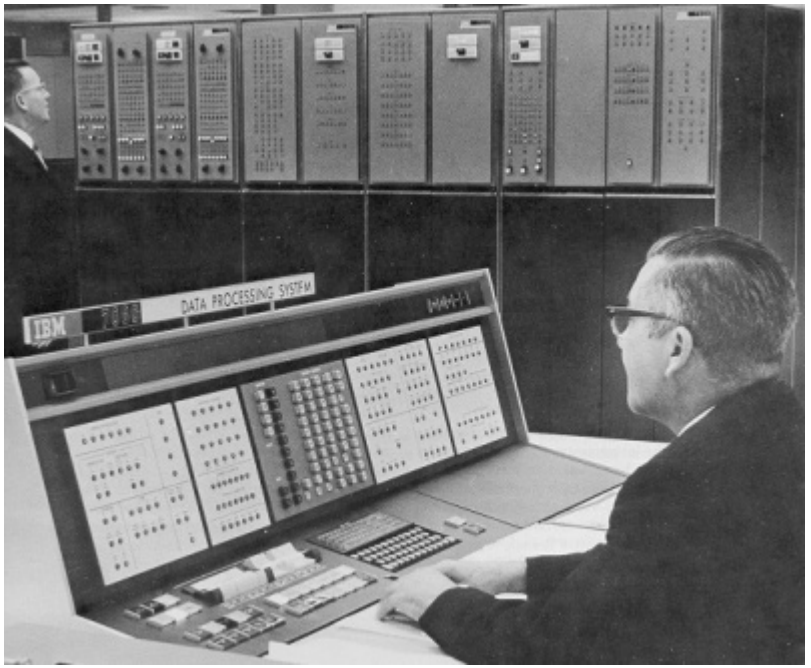
Vint Cerf
Father of the Internet

Martin Cooper
Father of the Cell Phone

Thanks go to Mike Coop –ThinkSmartGrid for references/comparisons

Without Interoperability Standards/Testing We Couldn't Go From This….

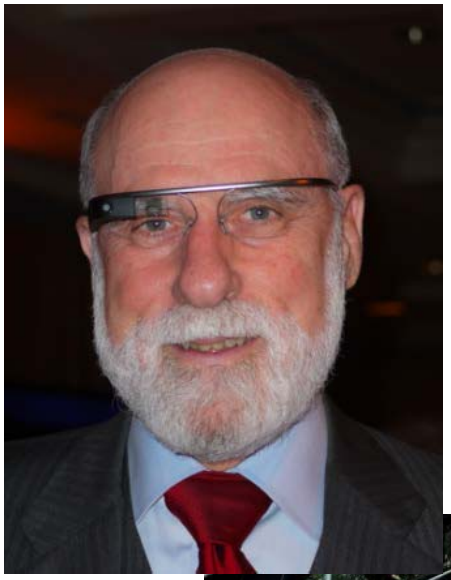
Vintage ATMs



Vintage Computing/Early Networks

Vintage Analog Brick Phones

To Today's Version of ATM, Internet, and Cell Phones



Highly Interoperable ATM networks, Cell phone networks, Ethernet (data networks)- Vint Cerf with Google Glass/Google Car

EV Charging Interoperability Activities (eRoaming and cross platform exchange)

1) EVSE Access Control/Billing (Cloud/User-to-EVSE)

- Open Charge Point Protocol (**OCPP**) was initiated and adopted by several manufacturers in EU and US (Greenlots). http://www.ocpp.nl/ (Netherlands)
- **HUBJECT,** based in Germany has same goal of connecting e-mobility networks. Based on Open Intercharge Protocol (**OICP**) {BMW, Daimler, Siemens, Bosch, RWE and EnBW} www.hubject.com/pages/en/index.html#1-1-home.html
- **Intercharge** multi-platform access control of EVSEs - via QR code (below) on EVSE; via RFID, Smart Phone, or Plug-n-charge mode where vehicle-EVSE start the process (no user intervention) www.intercharge.eu/index.php?id=12&L=1

California Set to Enact Laws To Improve Access for Electric Car Charging

plugineurope.com/2013/09/california-set-to-enact-laws-to-improve-acces-for-electric-car-charging/

2) CEC/CARB Pressure to Resolve EVSE Access Interoperability gaps (Industry needs to fix it or they will)

Two laws pending in California (due Oct 13th):

- **AB1092:** Require building code changes so new multi-family dwellings are wired for EV charging infrastructure
- **SB454:** EV Charging Stations Open Access Act
- Multiple charging networks are being deployed across California without access interoperability- NEMA and other groups working on access control interoperability standards

California Set to Enact Laws To Improve Access for Electric Car Charging

- **AB1092 Summary:** Voluntary standard; how it is to be implemented is not specified, but 3% of multi-family dwelling parking to EV charging 'infrastructure', 10% for non-residential (office) parking for 'low emitting vehicles'
- **SB454 Summary:** Equal access to all charging stations regardless of membership; all fees (including roaming fees) must be fully disclosed; must allow use of a credit card for access. (essentially analogy to ATM machines)
- **CEC Interoperability Workshop** August 15, 2013:

1) What are the advantages of ensuring that EVSE in California have hardware interoperability?
2) Are there any disadvantages and if so what are they?
3) What are the overlapping issues and relationships between network and hardware interoperability?
4) Where do they intersect and what are the future implications of adopting network interoperability without hardware interoperability?
5) *How can the Open Charge Point Protocol used in Europe serve as an example to California?*

www.energy.ca.gov/calendar/index.php?com=detail&eID=1911

High Level OCPP Structure/Functions

25 operations are described within **OCPP** 1.5.

- 10 are initiated by the charge point
- 15 by the Central system.

- **Initiated by the charge point:** *Authorize, Boot Notification, Data Transfer, Diagnostics Status Notification, Firmware Status Notification, Heartbeat, Meter Values, Start Transaction, Status Notification* and *Stop Transaction*.
- **Initiated by the central system:** *Cancel Reservation, Change Availability, Change Configuration, Clear Cache, Data Transfer, Get Configuration, Get Diagnostics, Get Local List Version, Remote Start Transaction, Remote Stop Transaction, Reserve Now, Reset, Send Local List, Unlock Connector* and *Update Firmware*.

PEV-EVSE Charging Interoperability Activities Analog/interlock control and recovery (J2953)

3) SAE Committee: PEV-EVSE Interoperability Standard

- Requirements/procedure documents in publication process
- Focus on separating the terms ‘compatibility and compliance’ from interoperability. Interoperable specific to PEV-EVSE pair
- Large number of combinations (~20 PEVs *~40 EVSE=800)
- ANL is developing software/hardware to conduct tests and evaluate interoperability per J2953; running 5 PEV/10 EVSE
- Former FOA239 DOE funded testing by Ecotality is on hold

Mechanical Interoperability Insertion/extraction Force Test Fixture

Prototype J1772 pass through measurement equipment with minimal parasitic effects

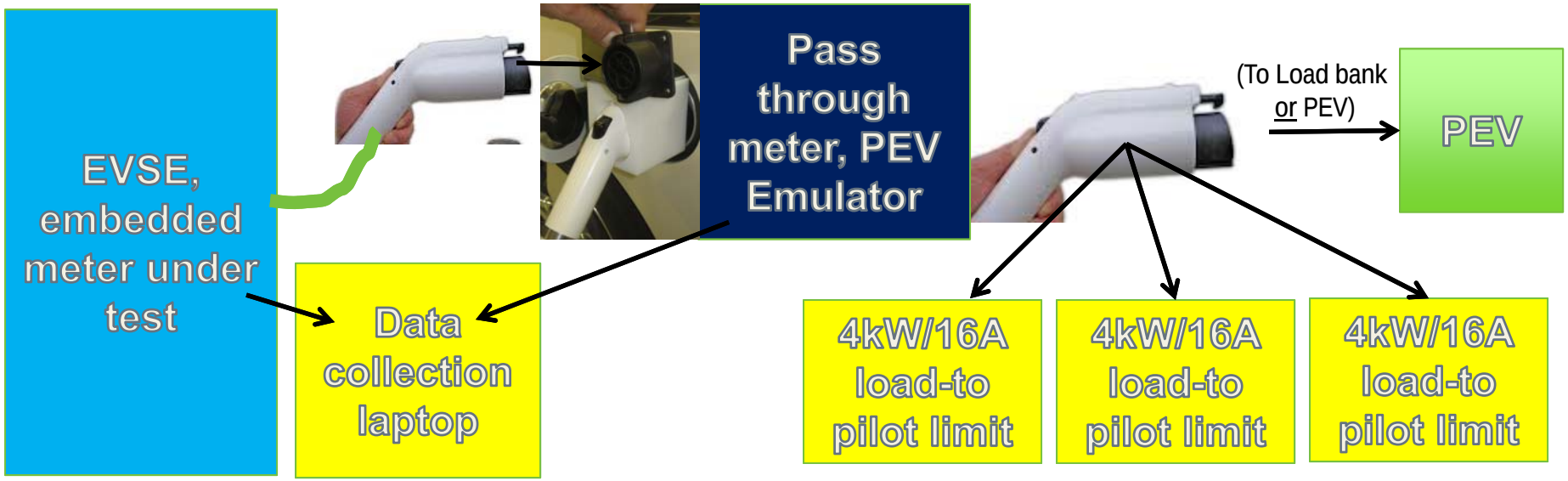
US-EU Joint EV-Smart Grid Interoperability Center, at ANL (July Opening)

Vehicle Lab, Embedded Controls Lab, Battery Systems/Charging Lab, Campus Wide Charging Network

NIST Handbook 44 EVSE Energy Delivery Field Verification Tool (state level certificates)

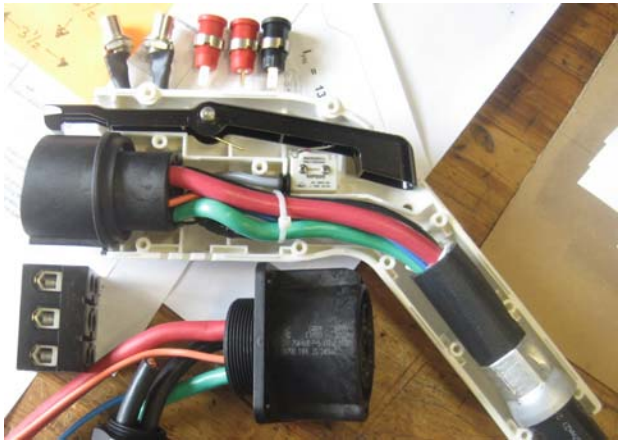
Proposed Field Verification of EVSE Energy Delivered to PEV, Analogous to Liquid Fuel dispensing verification for ICEs.

- Measure actual delivered AC energy to vehicle or emulator
- Tool is based on an SAE J1772 pass through coupler, with built in NIST traceable meter, PEV control emulator and pilot signal current controlled air cooled resistor load bank.



HB 44 EVSE Energy Delivery Field Verification Tool (estimate <$1000 cost)

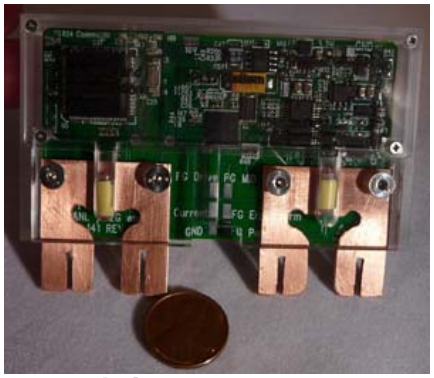
Representative hardware for EVSE Energy field verification tool



75A J1772 pass through tool pilot/prox AC terminals to meter and Resistive load banks {$300}

2” x 2” x ½” PEV emulator load controller (BMS based) {$250}

4kW (each) air cooled load, w/ SSR current regulator from PEV emulator-load controller {$100 each}- up to 5=20kW



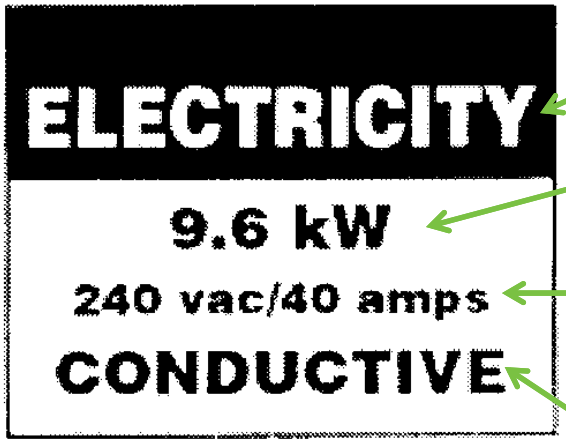
75A ANL Modular EUMD- .1% accuracy {$50}

Other modular submeters w/serial data {$300-$1000}

Laptop to access EVSE meter data and field tool meter data {$300-$1000}

16CFR309.18 Alternative Fuels (Electricity) Dispensing Device Placard Requirements

www.law.cornell.edu/cfr/text/16/309.17 Sample FTC Non-Liquid Alternative Fuel Label 16CFR part 309, Appendix A



3”Wide x 2.5”High

Fuel Type (electricity)

Power Delivered (40A*240V=9600W)

Type of Supply (possibly non-fixed current) (Voltage, Current, AC, or DC)

Type of coupling; wireless, or conductive

Takeaway: Even though 16CFR309 Non-Liquid Alternative Fuel Placarding is not currently enforced, in light of upcoming changes to NIST HB130/HB44 method of sale of electricity as a fuel, **placard requirements will be enforced.**

(3) Electric vehicle fuel dispensing system labels. The label is 3″ (7.62 cm) wide × 2 1/2 ″ (6.35 cm) long. “Helvetica black” type is used throughout. All type is centered. The band at the top of the label contains the common identifier of the fuel. This band should measure 1″ (2.54 cm) deep. Spacing of the common identifier is 1/4 ″ (.64 cm) from the top of the label and 3/16 ″ (.48 cm) from the bottom of the black band, centered horizontally within the black band. The first line of type beneath the black band is 3/16 ″ (.48 cm) from the bottom of the black band. All type below the black band is centered horizontally, with 1/8 ″ (.32 cm) between lines. The bottom line of type is 1/4 ″ (.64 cm) from the bottom of the label. All type should fall no closer than 3/16 ″ (.48 cm) from the side edges of the label.

NEC 2014 Article 625.14
New Opportunities to Innovate/Leverage

- **625.14 Rating**
  - Modified per TIA 70-11-2 - Electric vehicle supply equipment shall have sufficient rating to supply the load served. Electric vehicle charging loads shall be considered to be continuous loads for the purposes of this article. Where an automatic load management system is used, the **maximum** electric vehicle supply equipment **load on a service** and feeder shall be the **maximum load permitted by the automatic load management system.**

- **Translation:** Formerly EVSE load to the branch circuit was fixed by the EVSE rating (continuous). Now it is determined by load management system.
- This means that MANY EVSE modules can be connected to a single branch circuit. I.e. 10 EVSEs on a single 40A branch circuit, as long as only 32A max is drawn by any/all EVSEs.

White Paper/Proof of Concept Experiment: Level 1 EVSEs vs managed Level 2 EVSEs

Baseline Infrastructure Assumptions: Workplace Charging, 50kVA transformer/panel board

CASE 1: Level 1 Outlets Installed for Workplace Charging
- as per NEC, circuit rating 125% of load (20A breaker)
- 50kW/120v=416A or **~20 Level 1 EVSE outlets**

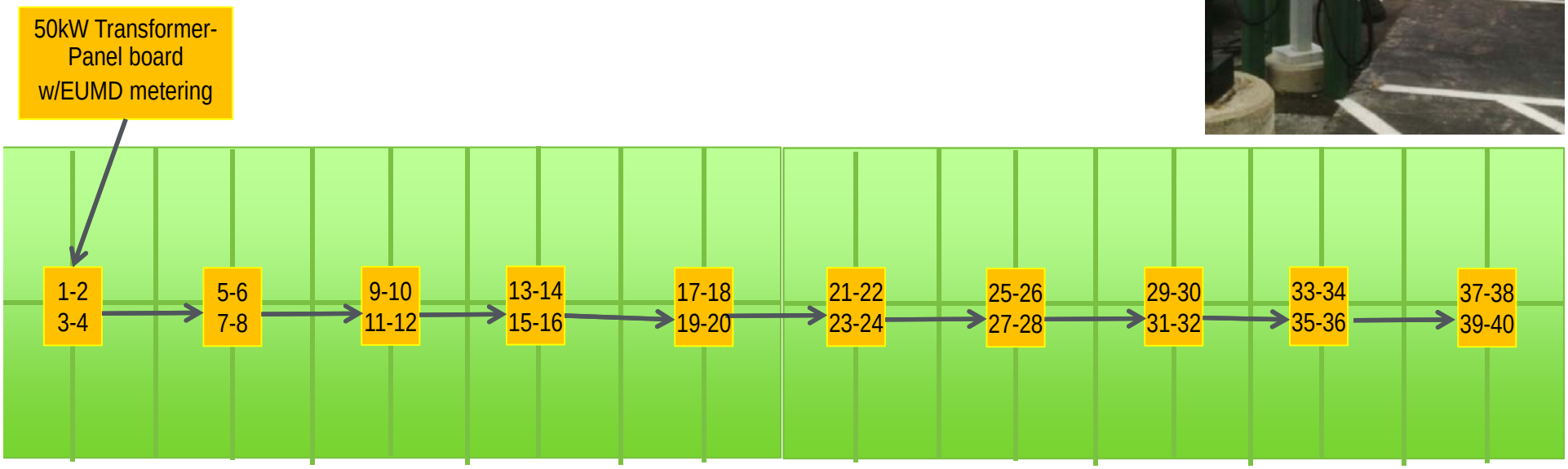
CASE 2: Level 2 (fixed) EVSEs for Workplace Charging
- as per NEC, circuit rating 125% of load (40A breaker)
- 50kW/240v=208A or **~5 Level 2 (7.7kW) EVSE stations**

CASE 3: Level 2 (adjustable/scheduled) managed EVSEs
- as per NEC625.14 (2014), circuit rating is managed
- 50kW/240v=208A*.8=166A (**40kW) which could be**
  - **40 EVSEs evenly divided to 1000W each-all on**
  - **20 of 40 EVSEs active at 2000W each**
  - **5 of 40 EVSEs active at 7700W each**

EVSE Hardware/Electrical Optimization

Reduce costs by minimizing packaging/grouping EVSEs

- Focus on modular solution: 4 (J1772) outputs per enclosure, mounted in center of 4 parking stalls
- 40 (J1772) 32A outputs in 10 enclosures covers 40 parking stalls (two adjacent rows)
- Production 4 output EVSE (AV) shown here (not optimized for packaging/cost)



Proof of Concept (low frills) Modular EVSE
Target cost $1000/4 or $250 per vehicle

Package 4 EVSEs controllers/contactors/cords

- Plain Steel (~12” square weatherproof enclosure) containing 4 DIN rail intelligent EVSE controllers (below)
- 4 paired DIN rail 40A contactors per enclosure
- RS485 Modbus network- EVSEs/EUMDs/manager uPC

Conclusions:

1. **Interoperability is critical for customer satisfaction and future product improvements/closing definition gaps.**

2. **ANL is interoperability standards development, creating and validating testing solutions as well as hosting the EV-Smart Grid Interoperability Center for DOE**

3. **Updates to NIST Handbook 130(Method of Sale of Electricity as a fuel) and Handbook 44 (measurement methods) will impact placarding and verification of "PEV fueling" at the state level.**

4. **Changes in NEC625 (2014) offer new opportunities to optimize EVSE deployment systems.**

BACKUP SLIDES

Dual Output DC Charging stations
Level 1, Level 2 DC Combo; CHAdeMO

Selection of IEC/SAE DC combo charging station vendors
ABB, BTCP, Delta, Eaton, Efacec, IES, Siemens, DBT

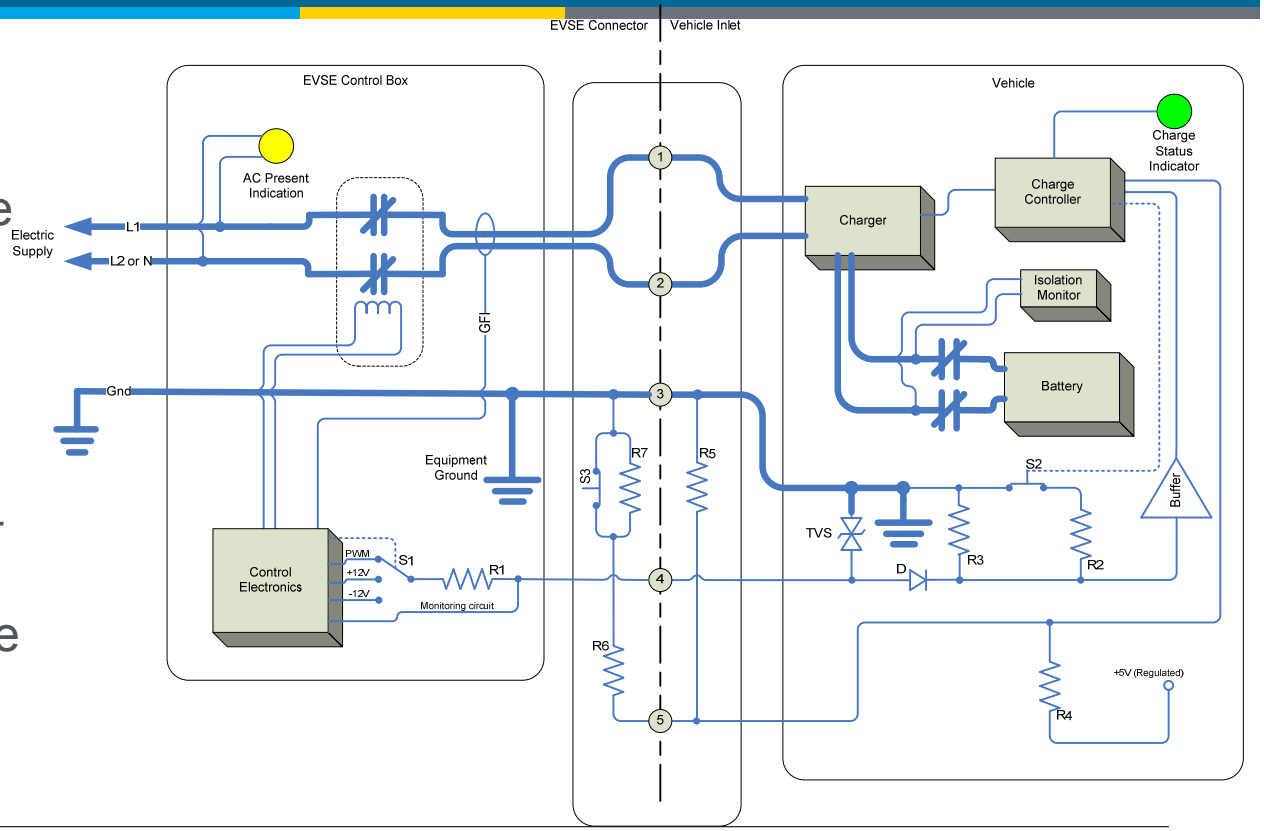
How fast can a PEV be charge? (It depends)

- Level 1 J1772-DC= 80*400=32kW*4=132 miles per hour of charging, or 132/60 minutes= **2.2 miles/minute**
- Level 2 J1772-DC= 200*400=80kW*4=320 miles per hour of charging, or 320/60 minutes= **5.33 miles/minute**
- Level 3 J1772-DC= 400*400=160kW*4=640 miles per hour of charging, or 640/60 minutes= **10.66 miles/minute**

The broad answer is "It depends", and above are some examples of the typical parameters (4 miles/kWhr, ~400vdc battery).

Equipped to Charge…..Safely

- General Purpose of Electric Vehicle Supply Equipment (EVSE) is to be an intelligent interlocked coupling system
- AC, DC, or wireless high frequency resonant AC
- Typical crossover from on-board (AC) to off-board (DC) charging is ~6kW due to volume/cost

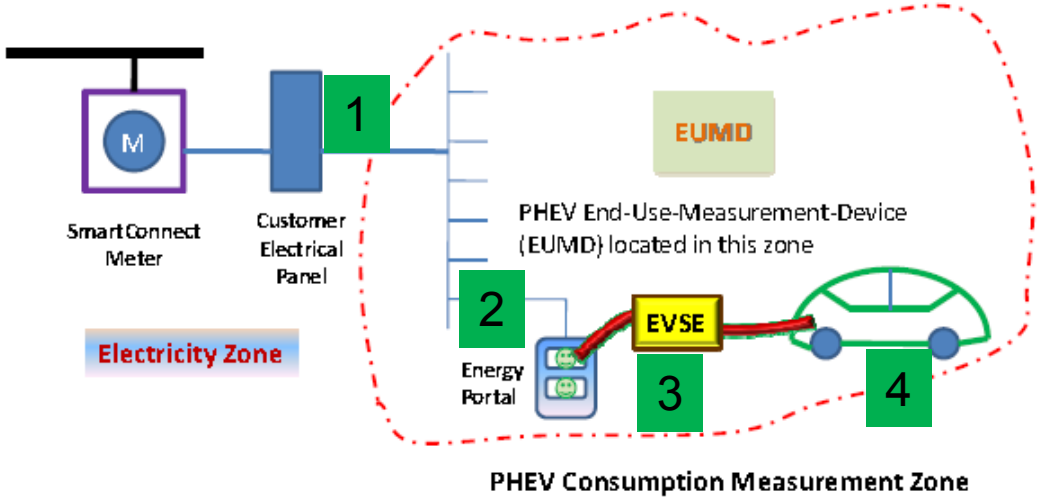


Contact #	Connector Function	Vehicle Inlet Function	Description
1	AC Power (L1)	Charger 1	Power for AC Level 1 and 2
2	AC Power (L2,N)	Charger 2	Power for AC Level 1 and 2
3	Equipment ground	Chassis ground	Connect EVSE equipment grounding conductor to EV/PHEV chassis ground during charging
4	Control pilot	Control pilot	Primary control conductor (operation described in Section 5)
5	Proximity Detection	Proximity Detection	Allows vehicle to detect presence of charge connector

Where Does the End Use Monitoring Device (EUMD) Reside? Depends on Perspective

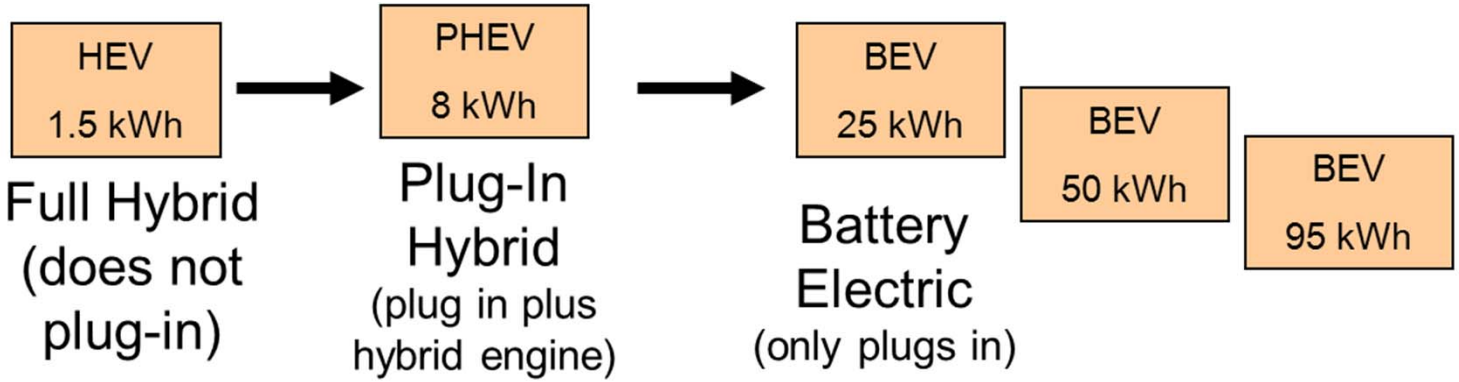
The UEMD measures just the branch circuit power flow to the EV, but may be located in different segments of that branch.

1) **Utilities** tend to favor locating it in an outdoor, technician accessible area, such as **next to the main meter**; possibly as a fused sub-panel with dedicated run to EVSE.
2) **Home Owners** may want it next to their service panel or in garage **near the EVSE**.
3) **EVSE manufacturers** want to build it into the EVSE, or in a socket **in the EVSE**.
4) **Auto manufacturers** may want the EUMD **on-board the vehicle** to simplify access to EUMD information.

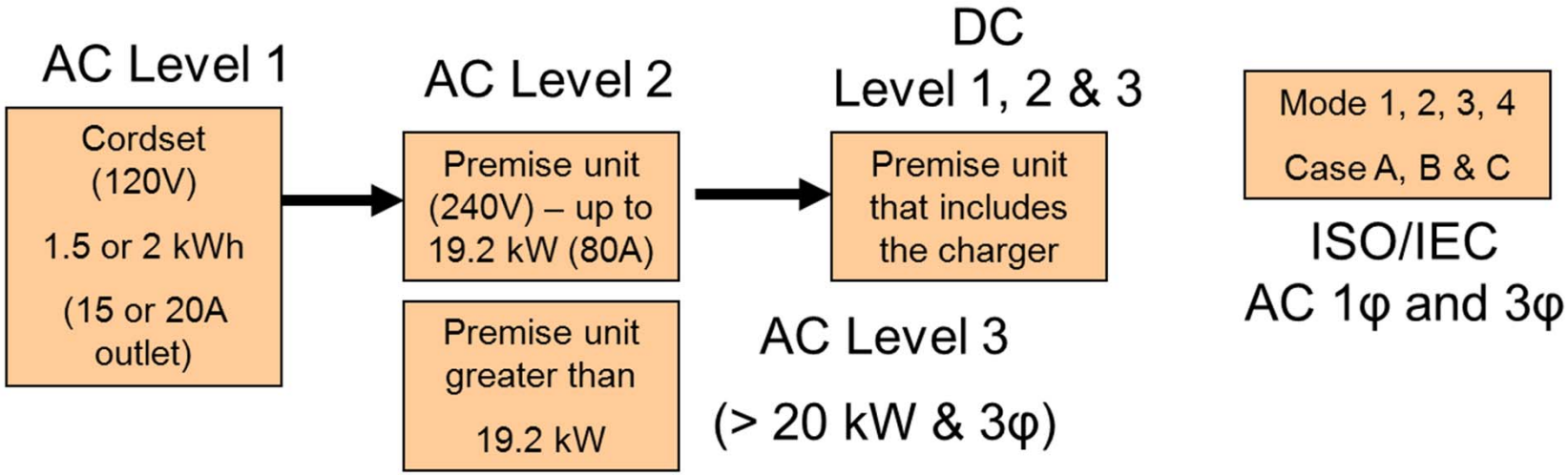


Vehicle & Supply Equipment Variations

Typical Vehicle Rechargeable Energy Storage System (RESS) Capacity size variations:



Electric Vehicle Supply Equipment (EVSE) Connection architectures:



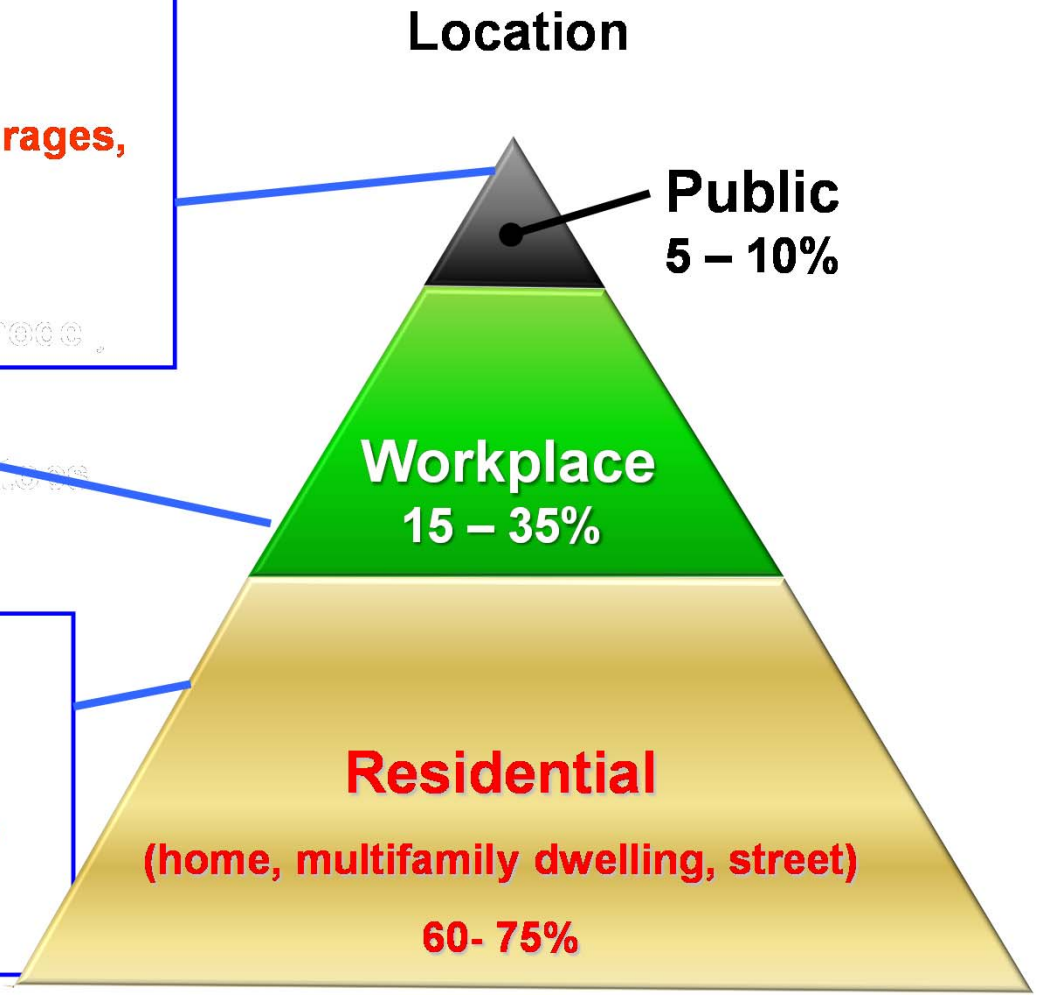
Charge location & power levels

Power Level Summary

- AC L1 (1.4 kW)
  - Street parking, parking garages, businesses
- AC L2 (7 kW)
  - Parking lots, parking garages, businesses
- DC L1 (35-45 kW)
- DC L2 (50-100 kW)
- DC L3 (150 kW)

- AC L1 (1.4 kW)
- AC L2
  - 7 kW
- DC L1

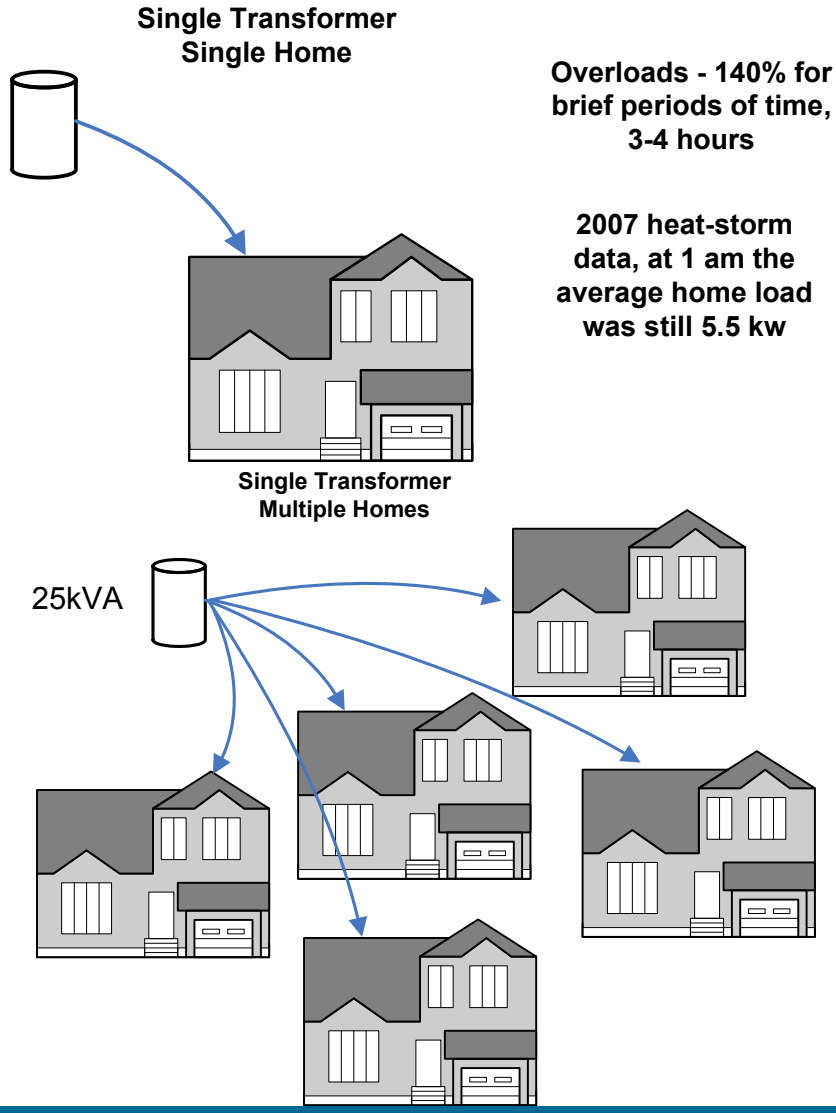
- AC L1 (1.4 kW)
- AC L2
  - 7 kW – most installations
  - 20 kW – allowed by J1772™
- DC L1 (10-20 kW)



Source: R. Scholer VPPC , 2011- Smart Grid Charging and V2G

Typical home loads and service
(sized for average, not peak demands)

		Watts	
	Totals	AC	Heat
Sink Disposal	1,000.00	1,000.00	1,000.00
Water Heater	2,400.00	2,400.00	2,400.00
Garage Door	1,500.00	1,500.00	1,500.00
Dish Washer	1,600.00	1,600.00	1,600.00
Clothes Dryers	5,000.00	5,000.00	5,000.00
Oven	1,500.00	1,500.00	1,500.00
Range	1,500.00	1,500.00	1,500.00
AC compressor	4,000.00		
condenser fan	240.00		
air handler	345.00	4,585.00	
heat coils	15,000.00		18,845.00
space heater	3,500.00		
Pool pump			
Lighting	1,200.00	1,200.00	1,200.00
Plazma TV			
Other			
	38,785.00	20,285.00	34,545.00
Less heat and AC		15,700.00	15,700.00
BEV	19,200.00	19,200.00	19,200.00
PHEV	3,300.00	3,300.00	3,300.00
Peak Values: BEV added	57,985.00	39,485.00	53,745.00
Peak Values: PHEV added	42,085.00	23,585.00	37,845.00
Peak Values: Both	61,285.00	58,485.00	72,745.00



Overloads - 140% for brief periods of time, 3-4 hours

2007 heat-storm data, at 1 am the average home load was still 5.5 kw